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SHORT COMMUNICATION

EFFECT OF SEED INOCULATION AND FARMYARD MANURING ON NITROGEN BALANCE AND YIELD IN RAJMASH (*PHASEOLUS VULGARIS*)

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A field experiment was conducted during 1999 and 2000 at Highland Research and Extension Centre, Kukumseri, Lahaul and Spiti to study the influence of *Rhizobium* inoculation, incorporation of farmyard manure (FYM) and fertilizer nitrogen (N) on nodule number and weight, nitrogen fixation in rajmash and N balance in the soil. The inoculation of *Rhizobium leguminosarum* bv.*phaseoli* to seed and incorporation of FYM one week before sowing of rajmash increased the seed yield. Similarly, inoculation of seed enhanced N fixation and incorporation of FYM left a net positive balance of 42 and 84 kg N, respectively. Though application of excess nitrogen also showed a net positive N balance, it reduced N fixation in rajmash. A higher accumulation rate of available N at the all growth stages of rajmash was observed with incorporation of FYM and inoculation of seed over control.

Key words: **Lahaul valley, N balance, rajmash yield**

Among the leguminous crop, rajmash is the most important crop of Lahaul valley of Himachal Pradesh. Generally N fertilization is not recommended for leguminous crops, but it is always stressed that organic manure should be applied along with *Rhizobium* culture. Organic manure does not take part directly in N fixation, but its incorporation into the soil improves the soil physical conditions and provide conducive environment for proper establishment of *Rhizobium* and growth of nodules (Fried *et al.* 1983). Legumes enrich the soil by adding N, and that depends on magnitude of the N fixed by legume and its distribution in different plant parts (Eaglesham *et al.* 1982). According to Peoples and Craswell (1992), the net contribution of legumes towards soil enrichment was very little and on other hand net negative enrichment of soil was observed by Chandel *et al.* (1989). Plant and soil management practices also influence the N_2 fixation (Peoples *et al*.1995). However, the information on changes in soil N with the crop growth is limited. The present study was carried out to find out the influence of *Rhizobium* inoculation and FYM on fixation of N in rajmash, its contribution to soil N with crop growth.

The field experiment was conducted on 'Kanchan' rajmash during summer seasons of 1999, 2000 (May to September) at the experimental farm of Highland Research and Extension Centre, Kukumseri, Lahaul and Spiti, (32° 44' 15" N and 76° 41' 23" E at an elevation of 2672 m) falling in dry temperate zone of Himachal Pradesh. Twelve treatments consisting of uninoculated (control), inoculated and 3t FYM ha^{-1} on fresh weight basis (N = 0.70%, 3t FYM approximately supplied 15kg N/ha/season) as main plot treatments were super imposed in four fertilizer nitrogen levels as subplot treatments viz. 0, 15, 30, 45 kg N/ha. Rajmash var. Kanchan was sown on May 31 and on May 6 during

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first and 2nd year in plots of 2.5 x 2 m . Farmyard manure was applied one week before sowing. Seed inoculation with *Rhizobium leguminosarum* bv. *phaseoli* culture was carried out by making 10% sugar solution and sowing was done in rows spaced 45 x 5 cm at apart and crop was harvested 110 days after sowing. A basal dose of 26 kg P and 25 kg K was applied before ploughing as single super phosphate, muriate of potash, respectively. Soil (0-20 cm) samples were collected at 30, 60 , 90 and 110 (harvest) days after sowing (DAS) for monitoring changes in available N status in the soil. From each treatment five plants were selected randomly and uprooted with the help of spade along with the soil and soil adhered to root was removed gently by water. The nodules were removed and counted and N content was determined in fresh nodules and was reported on dry weight basis. At maturity, seed and straw samples were analyzed for determining the uptake. After two seasons, soil samples were analyzed for total N to calculate N-fixation and N balances. The accumulation rate of N(kg/ha/d) was computed by dividing the change in available N content during two successive growth intervals by its duration (days). Similarly fixation of nitrogen by rajmash was computed by monitoring the changes in the total nitrogen as well as that removed in the crop (Lyon and Bizzel,1934) by using the equation.

NF = (NR-NA+N)/No. of rajmash crops

where, NF = Nitrogen fixed by rajmash (kg ha^{-1}), N = Changes in total N (+) addition and depletion (-)of N in soil (kg ha^{-1}), NR = Total N removed by crops (kg ha^{-1}), NA = Total N applied through fertilizer or manure (kg ha^{-1})

Rhizobium inoculation and incorporation of FYM increased significantly the seed yield of rajmash in both the years over uninoculated control (Table 1). Seed yield in *Rhizobium* inoculated plots or FYM was statistically at par. The trend was same with respect to protein content. Among the nitrogen levels, N_3 recorded a significantly higher seed yield over N_0, N_1 and N_2 in 1999. However during 2000, N_3 and N_2 were at par. But the mean yield of both the years indicated that with increase in N application, there was a significant increase in seed yield up to N_3(45kg/ha). Sahu *et al*. (1994) also reported increase in rajmash yield with addition of nitrogen. The increase in seed yield with inoculation of *Rhizobium* appears to be due to proper establishment and greater infection of *Rhizobium* strains at more number of sites as was evident from the larger and more number of nodules and their higher weight which resulted in supply of N in large quantity to plant. The results are in line with Kundu *et al*. (1993) who reported that higher yields in rajmash were related with higher N fixation and nodulation. Though the role of FYM in N fixation is not well established, the increased seed yield and thus higher N fixation in FYM treated plots might be due to availability of larger amounts of photosynthates to both the nodules as well as seed because of better crop growth with the additional nutrients supplied and better environment provided by FYM. Both *Rhizobium* inoculation to seed and incorporation of FYM significantly increased the straw yield over control. FYM treatment resulted in significantly higher straw yield than inoculated treatment. The trends in straw yield were similar to seed yield with respect to effect of nitrogen.

Nodule number increased up to 60 DAS. FYM recorded the maximum nodule number at all the three growth stages. The higher fixation by crop and greater amount of N accumulation in the soil may explain the increase in nodule number and weight. Significant differences were observed in nodule weight (mg $plant^{-1}$) at all the three stages of growth. Highest nodule weight was recorded under FYM treatment; peak was at 60 DAS and declined thereafter up to 90 DAS. Nitrogen content of nodule followed the same trend as that of nodule weight $plant^{-1}$.

FYM application and inoculation of seeds significantly increased N fixation over uninoculated control. Highest build up of total N after two seasons in soil was also recorded in the plots which received FYM which is also evident from available N in soil. The higher N fixation by rajmash with *Rhizobium* inoculation and incorporation of FYM was due to large number of nodules and their weight. Kundu *et. al.* (1996) also noted an increase in N fixation on FYM incorporation in soybean. As the application of fertilizer nitrogen increased, the increase in build up of total N also occurred, but a reverse trend was observed with biological N fixation which suggests

Table 1. Effect of seed inoculation with *Rhizobium* and FYM application on seed and straw yield, N removal by rajmash and N build up in soil.

Treatment	Seed(qha^{-1}) 1999	2000	Mean	Straw(qha^{-1}) 1999	2000	Mean	N uptake by seed + straw in two years	Build up of N in soil ($kgha^{-1}$)	Protein (%) Mean
Uninoculated (control)	13.7	15.1	14.4	20.5	22.6	21.5	110.7	25	17.5
Inoculated	15.6	18.1	16.8	22.6	27.2	24.9	119.2	42	19.3
FYM	18.0	20.3	19.2	27.0	30.0	28.5	136.4	84	19.3
LSD(5%)	1.6	2.9		2.3	2.5	3.1	12.6	14	1.0
Nitrogen($kgha^{-1}$)									
N_0	10.1	13.2	11.6	14.8	19.8	17.3	83.9	19	17.5
N_1	12.9	16.2	14.5	18.8	24.1	21.5	104.4	50	18.7
N_2	16.8	21.4	19.1	25.2	31.8	28.5	138.5	85	19.3
N_3	20.7	22.8	21.7	31.0	33.6	32.3	155.8	95	20.0
LSD(5%)	1.9	2.3		4.3	3.9	3.6	17.5	12	1.2

N_1=15 kg, N_2=30 kg, N_3=45 kg/ha, FYM-3.0 t/ha

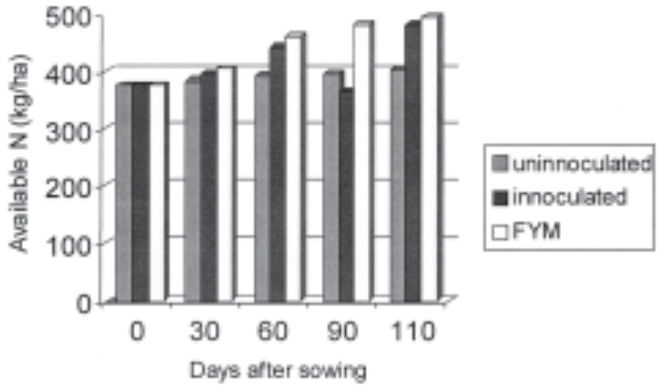

Fig. 1. Effect of inoculation of seeds with *Rhizobium* sp. and FYM application on accumulation of available soil N

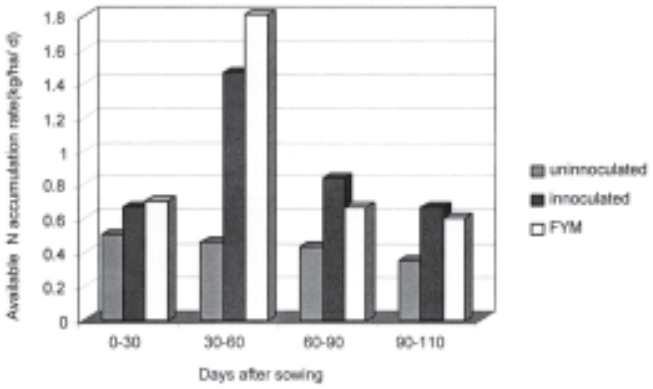

Fig. 2. Effect of seed inoculation with *Rhizobium* sp. and FYM on rate of accumulation of available N in soil at different growth stages of rajmash

that application of excess N decreases N fixation. FYM application and *Rhizobium* inoculation to seed increased the available N in soil throughout the crop growth period (Fig. 1). The differences among the treatments were more pronounced at early and later stages of the crop. The accumulation of large quantities of available N in FYM and inoculated plots may be due to release of higher amounts of nitrogenous compounds by root nodule at early stages of growth and their subsequent decomposition at later stages. It was observed that some of the nodules were active even at 60 DAS. Thus, the higher availability of N under these treatments lead to higher seed yield.

Table 2. Nodule number, weight and nitrogen content as influenced by seed inoculation with *Rhizobium*, FYM application and N fertilizer at different growth stages of rajmash.

Treatment	No. per plant			Dry wt.(mg plant^{-1})			N content (mg plant^{-1})		
	30	60	90	30	60	90	30	60	90
Uninoculated (control)	28	38	34	15	24	18	12.4	24.1	14.5
Inoculated	54	69	50	41	47	38	21.3	39.3	17.6
FYM	60	72	57	45	49	42	22.1	45.6	18.2
CD P(0.05)	8	12	10	6	7	6	3	8	NS
Nitrogen (kgha^{-1})									
N_0	34	36	30	16	17	12	13.3	25.1	14.2
N_1	42	47	36	19	21	15	22.2	27.2	15.2
N_2	56	68	40	21	27	20	22.7	29.3	16.1
N_3	60	70	42	23	29	18	23.5	30.5	17.3
CD P(0.05)	7	8	4	2	4	3	1.5	1.4	NS

N_1=15 kg, N_2=30 kg, N_3=45 kg/ha, FYM-3.0 t/ha

Table 3. Effect of seed inoculation with Rhizobuim and fertilizer application on fixation of atmospheric N

Treatment	Total N applied	Total N removed by Rajmash	Build up of N on soil (kgha^{-1})	N fixed (B+C-A)
	A	B	C	No. of rajmash crops (2)
Uninoculated	52.5	110.7	+25	41.8
Inoculated	52.5	119.2	+42	54.5
FYM (3 t/h)	67.5	136.4	+84	76.5
LSD(5%)	-	-	6.5	23.5
Nitrogen (kgha^{-1})				
N_0	10	83.9	+19	46.5
N_1	40	104.4	+50	57.2
N_2	70	138.5	+85	76.8
N_3	130	155.8	+95	60.4
LSD(5%)	-	-	21	20

N_1=15 kg, N_2=30 kg, N_3=45 kg/ha, FYM-3.0 t/ha

The rate of available N accumulation in soil was maximum during 30-60 DAS followed by 90-110 and 0-30 DAS (Fig. 2). Sudden drop in N accumulation was found during 60-90 DAS which is obviously due to competition of sink (pods) for N during the period. N accumulation at the later stages may probably be due to decline in demand from sink (pods) for N and its subsequent addition to the soil after decomposition of nodule and roots. Among the three treatments, FYM recorded the highest N accumulation followed by inoculation treatment.

Hence, from the study it is concluded that cultivation of rajmash is N restorative and FYM application is better than seed inoculation with *Rhizobium* in N fixation and in increasing the productivity of rajmash in Lahaul valley of H.P.

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